

OPINION OF REVIEWER

on the competition announced in State Gazette no. 36 of 22.03.2019, for the awarding of the academic position "Professor" in the direction 4.2. Chemical Sciences (Chemical Kinetics and Catalysis) for the Laboratory Reactivity of solid surfaces, Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences.

Reviewer: Assoc. Prof. Hristo Gospodinov Kolev, PhD, Institute of Catalysis, BAS

Participant: The only candidate Assoc. Prof. Mihail Yordanov Mihailov, PhD, from the Institute of General and Inorganic Chemistry at the Bulgarian Academy of Sciences.

Assoc. Prof. Dr. Mihail Mihailov is an experienced employee of the Institute of General and Inorganic Chemistry. After defending his dissertation with subject "Synthesis and characterization of applied dispersed nickel catalysts. Influence of the support on the properties of nickel "in 2002, he occupies consecutively positions of assistant (2003-2008) and associate professor (2008 until now) at the same institute. Thus, formally Assoc. Prof. Mihail Mihaylov meets the requirements for participation in the competition. The applicant exceeds the necessary criteria under Art. 4 of the Regulations for the Conditions and the Order for Acquiring Academic Degrees and for Occupation Academic Positions at IGIC - BAS. He has co-authored 71 publications, 62 of them are published in journals with Impact Factor. Assoc. Prof. Mihail Mihailov participated in this competition with 23 publications, all of which are indexed with Q1. More than 1600 citations have been spotted on all of his publications. On the publications used for the competition are noted over 380 citations. The candidate's Hirsch index is 18, which shows the importance and topicality of his publications. For these parameters, Dr. Mihail Mihailov repeatedly exceeds the threshold for the competition to acquire academic position "Professor". Dr. Mihaylov is an active participant in 16 scientific research projects with different sources of funding. At 4 of them he is deputy head of the Bulgarian team on projects funded under FP7. He is the manager of 2 projects funded by the NSF. He is a supervisor for two PhD students and he is a consultant for another one. The candidate is a member of the scientific organizations Union of

Bulgarian Chemists, Bulgarian Catalytic Club now Society, Humboldt Union, IUPAC. Recognition of its scientific activity is also the following:

1. IGIC - BAS award for the best scientific publication with the participation of young scientists, 2005;
2. "Marin Drinov" Chemistry Prize for Young Scientists, 2003.
3. Scholarship Alexander von Humboldt, 2006.

He is a member of the Scientific Council of the IGIC-BAS since 2012 and he is currently the head of the laboratory "Reactivity of solid surfaces".

The research activity of Dr. Mihailov is focused on the development and use of the IR spectroscopy for obtaining information that is of fundamental importance for the study of chemistry of active solid surfaces, adsorbents and catalysts in their interaction with inorganic and organic gases or vapors. Studies are directed to implementation of easy transformation between Ce^{3+} and Ce^{4+} ions and creating/filling of oxygen vacancies in the structure of CeO_2 and its wide application in redox processes of carbon and nitrogen oxides. The analysis of the nature and reactivity of the formed adsorbates, as well as the mechanism clarifying of the rich variety of surface processes, were mainly investigated by IR Spectroscopy complemented by other analytical techniques such as X-ray Diffraction, X-ray Photoelectron Spectroscopy, Thermo Programmed Reduction, Electron Paramagnetic Resonance, Electron Microscopy, UV Spectroscopy, catalytic tests and theoretical modeling. The reactivity nature and the adsorption forms of number of surfaces have been studied. The surface forms of adsorption of nitrogen and carbon oxides on ceria have been systematically determined. The effects of stoichiometric and partially reduced form, as well as particle size, are investigated.

Another type of CO oxidation catalysts, investigated by the applicant are gold-containing catalysts applied to several supports La_2O_3 , MgO , SiO_2 . The CO oxidation mechanism has been explained with creation of active $\text{Au}^{\delta+}$ centers that help to form carbonate-like structures. For the first time, $\text{Au}^{\delta-}$ centers formed on SiO_2 support have been observed. They play an important role in processes occurring in reducing media such as WGS and PROX.

With help of IR probe molecules, the candidate deals with the determination of the degree of oxidation, electrophilicity, coordination status and localization of iron cations positioned in nonstoichiometric-lattice positions for various zeolites modified with iron-containing catalysts.

In recent years Dr. Mihailov deals with metal-organic frameworks. Data on purity, hydrothermal stability and acid-base properties have been obtained. Knowing these properties makes possible the use of metal-organic frameworks as catalysts and materials for hydrogen storage or separation of CO₂.

The applicant's main contributions can be summarized as follows:

1. It is proposed vibration frequencies revision of adsorption forms of NO_x and CO_x on ceria, which allows their reliable identification. This information is of importance for the study of chemistry on the surface of CeO₂, both oxidized and reduced.
2. New surface compounds were detected at NO adsorption on non-stoichiometric oxide and new mechanism for conversion of NO to N₂ were proposed. The formation of surface compounds azides N₃⁻ and NO²⁻ has been demonstrated.
3. It has been demonstrated that the isotope shift is reliable criterion for distinguishing between N-O and N-N stretching vibrations in use of isotopically labeled molecules. It is possible to distinguish oscillations involving one or more nitrogen atoms by adsorption of isotopic mixtures.
4. The adsorption forms CO_x on stoichiometric, reduced and hydroxylated ceria has been described in details.
5. Fundamental information on the overall NO_x interaction with ceria was obtained. It is shown in which case nitrites or nitrates are formed.
6. Two new mechanisms for the reductive conversion of NO to non-stoichiometric cerium dioxide (CeO_{2-x}) are proposed.

I do not have critical comments on the materials provided for the competition.

Conclusion:

The research of Assoc. Prof. Dr. Mihail Yordanov Mihailov fully corresponds to the subject of the announced competition for awarding the academic position "Professor". Dr. Mihailov is an excellent specialist in the field of catalysis and the use of the IR spectroscopy for elucidation of nature and reactivity of surfaces. The publishing activity after its habilitation, the citation on the published results, scientific and organizational activity, participation and management of projects fully corresponds to all requirements of the Academic Staff Development Law and the Regulations on the Conditions and Procedure for Acquisition of Academic Degrees and the Occupation of Academic Posts at the Institute of General and Inorganic Chemistry at the Bulgarian Academy of Sciences. Therefore, I confidently recommend to the members of the Scientific Jury and to the Scientific Council of the Institute of General and Inorganic Chemistry - BAS to award Assoc. Prof. Dr. Mihail Yordanov Mihailov with the academic position "Professor" in direction 4.2. Chemical Sciences (Chemical Kinetics and Catalysis).

19.07.2019

Sofia

Reviewer:

/Assoc. Prof. Dr. Hristo Kolev/